INTRODUCTION OF AOCS HARDWARE CONFIGURATION FOR COMS

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ABSTRACT: A part of the big differences between LEO(Low Earth Orbit) and GEO(Geostationary Earth Orbit) satellite is that transfer orbit is used or not or what tolerance of the position on the mission orbit is permitted. That is to say, the transfer orbit is not used and the constraint of orbit position is not adapted on LEO satellite. Whereas for GEO satellite case, the transfer orbit shall be used due to the very high altitude and the satellite shall be stayed in the station keeping box which is permitted on the mission orbit. These phases are functions for AOCS mission.
The aim of this paper is to introduce the AOCS hardware configuration for COMS (Communication, Ocean and Meteorological Satellite). The AOCS hardware of COMS consist of 3 Linear Analogue Sun Sensors (LIASS), 3 Bi-Axis Sun Sensors (BASS), 2 Infra-Red Earth Sensors (IRES), 3 Fiber Optical Gyroscopes (FOG), 5 momentum wheels and 14 thrusters. In this paper, each component is explained how to be used, how to locate and what relation between the AOCS algorithm and these components.

KEY WORDS: COMS, AOCS, Hardware Configuration, LIASS, BASS, IRES, FOG, Wheel, Thruster

1. INTRODUCTIONS

Geosynchronous orbit is the special orbit which rate is same as Earth rate. The orbit means all of circular orbit which altitude is 36000 km but almost of countries are using one geosynchronous orbit being on equator. This orbit is called to geostationary orbit. Because of the limited space to use, the geostationary orbit is managed by ITU (International Telecommunication Union) in part of the orbit slot and the frequency band.[Choi]

So, in advance of that a country has the technology to development a satellite, it is very important that a country has a satellite on geostationary in point of the space development status. Korea had taken two geostationary satellite, Koreasat 1 and 2 which had been launched at August 1995 and January 1996 on 116 degE. Since that time, Korea has took several satellites on geostationary orbit.[Hangbo]

In this situation, COMS (Communication, Ocean and Meteorological Satellite) development with EADS Astrium in France must be new jump in the space development status of Korea. COMS will be launched the early of 2009 as the first complex mission geostationary satellite in Korea.

A part of the big differences between LEO(Low Earth Orbit) and GEO(Geostationary Earth Orbit) satellite is that transfer orbit is used or not or what tolerance of the position on the mission orbit is permitted. That is to say, the transfer orbit is not used and the constraint of orbit position is not adapted on LEO satellite. Whereas for GEO satellite case, the transfer orbit shall be used due to the very high altitude and the satellite shall be stayed in the station keeping box which is permitted on the mission orbit. These phases are functions for AOCS mission of geostationary satellite.

The big difference may be found at the hardware configuration of AOCS. Sun sensors are located on several positions to acquire the satellite attitude at transfer orbit. Thrusters are located on East/West panel and South or North panel to control the attitude at transfer orbit and to perform the station keeping at mission orbit. Earth sensor of geostationary satellite has a mirror mechanism inside to detect Earth because the attitude manoeuvre of satellite is no large.

In this paper, the hardware configurations for COMS AOCS are introduced which perform the function of COMS AOCS. Sun sensor(LIASS, BASS), Earth sensor(IRES) and inertial measurement sensor(FOG) are described at chapter 2. Thrusters and reaction wheels are described at chapter 3.[Laine]

The following figure is the coordinate system for COMS AOCS

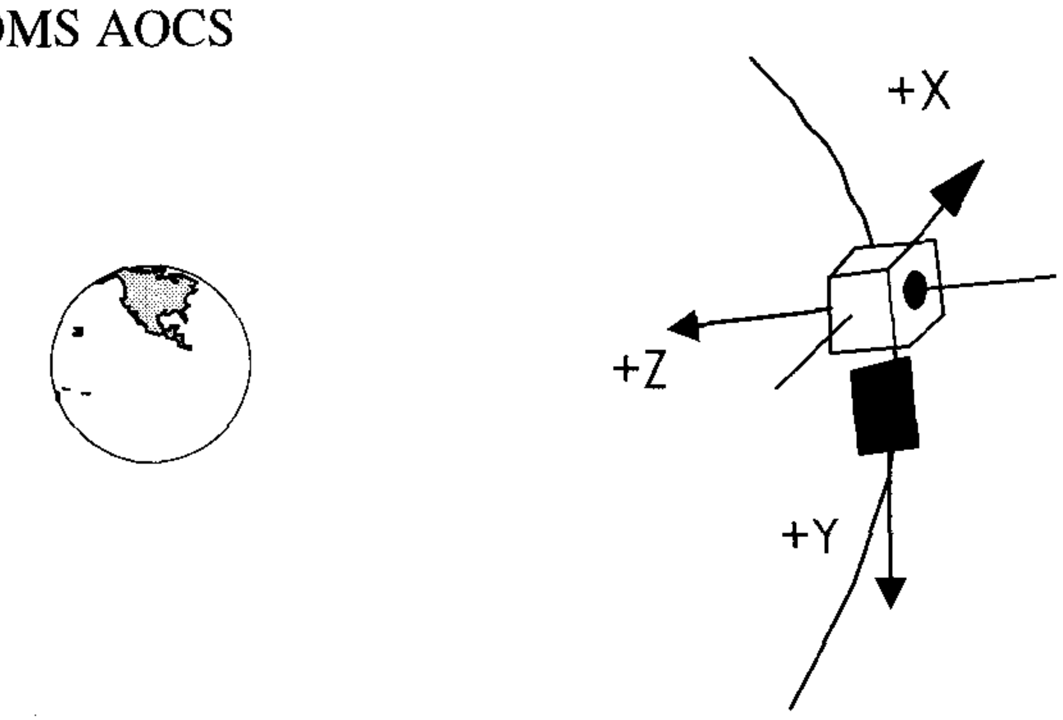

Figure 1. COMS coordinates definition

2. COMS AOCS SENSORS

2.1 BASS

The BASS(Bi-Axis Analogue Sun Sensor) is a wide-angle analogue Sun sensor which uses 5 x 5 mm² silicon solar cells. It delivers output currents which are proportional to the direction cosines of the Sun angles about two orthogonal axes. Internal redundancy is provided with two cells placed on each face of the central pyramid to which all eight cells are mounted.

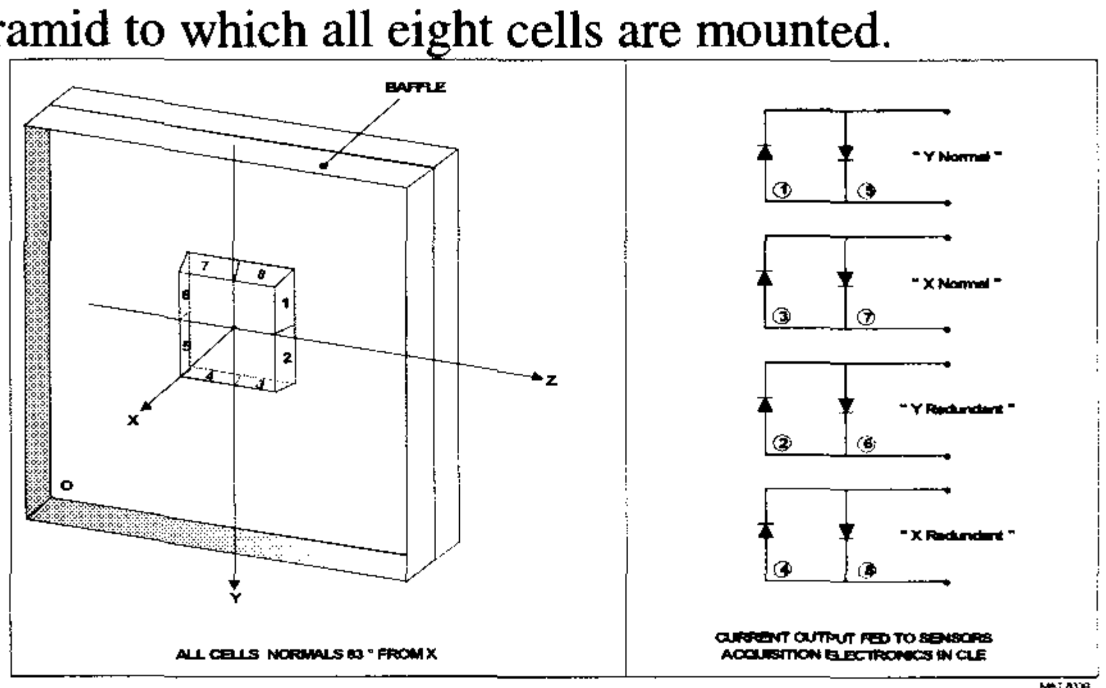

Figure 2. BASS solar cell implementation and wiring

There are one Zm BASS and two Xp/Xm BASS. The latter BASS are also named ACQp, and ACQm BASS respectively in acquisition mode. The Zm BASS is tilted around the pitch and roll axis for field of view accommodation purposes.

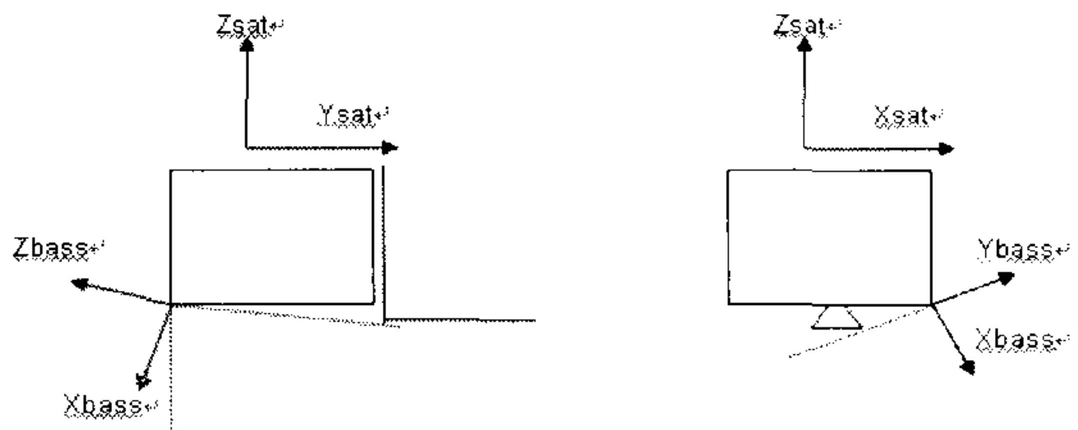

Figure 3. Zm BASS configuration

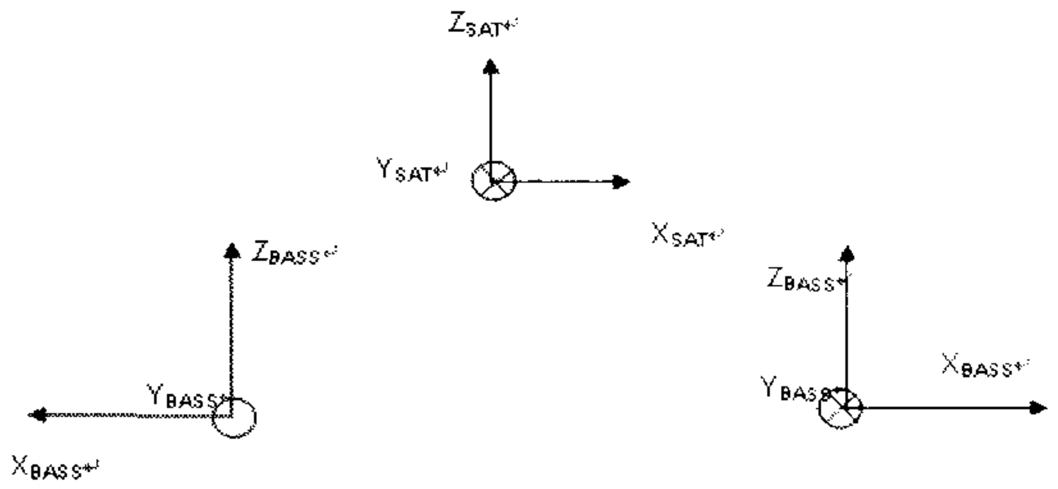

Figure 4. Xp/Xm BASS configuration

2.2 LIASS

The LIASS(Linear Analogue Sun Sensor) are mounted on the satellite for attitude determination during transfer orbit and on solar array to detect the angle of the incoming Sunlight related to the normal of the solar array surface. The LIASS is a wide angle sensor (± 30° Linear FOV ; ± 45° coarse FOV) and has internal redundant, using a pair of qualified silicon solar cells of 5 mm x 5 mm.

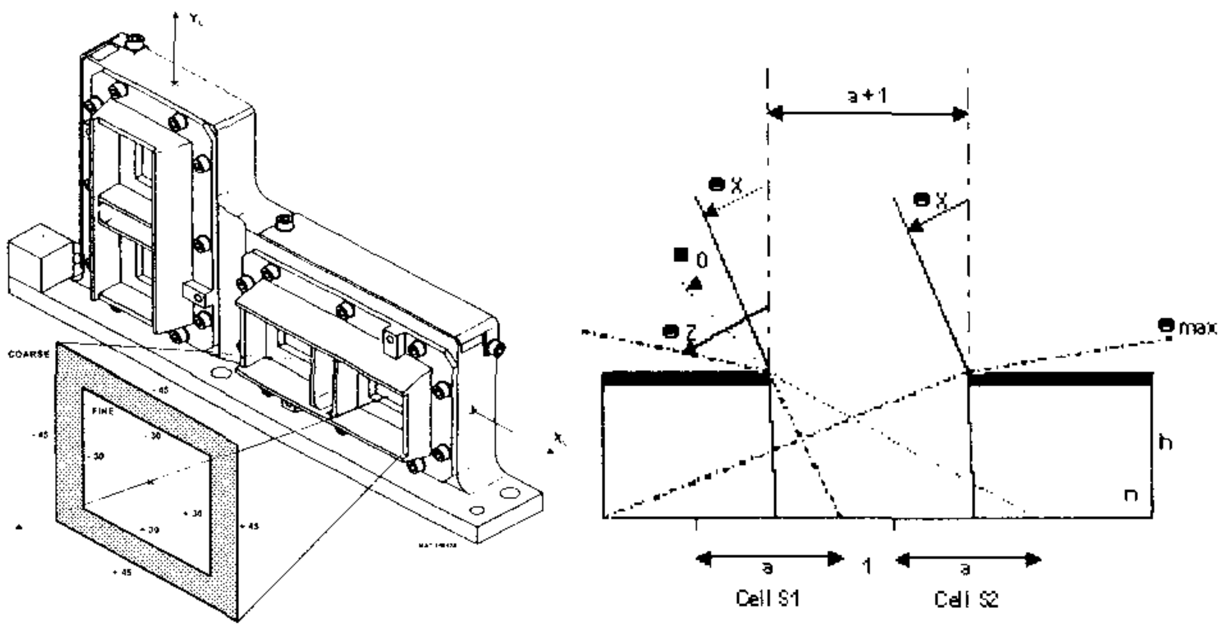

Figure 5. LIASS view and measurement principle

There are three LIASS: Yp SA LIASS mounted on Yp solar array, EA LIASS used for Earth Acquisition at Apogee and gyro calibration, BO LIASS used for Boost phase (see Figure 6).

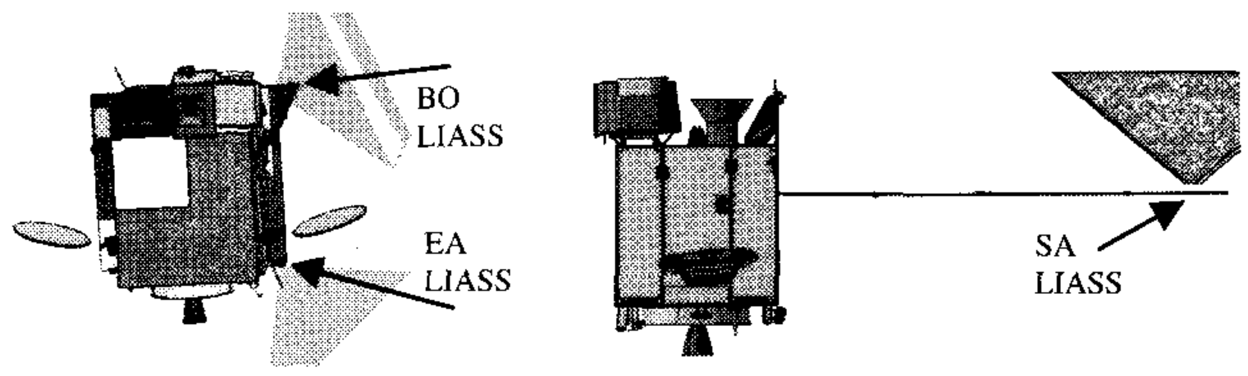

Figure 6. COMS LIASS configuration

2.3 IRES

The IRES(Infra-Red Earth Sensor) makes use of one single bolometer which collects the infrared radiation (14-16 micron wavelength) in a 1.8 x 1.8 square degree elementary field-of-view after successive reflections on a fixed then a rotating mirror. The sketch of the scanning geometry explain how a complete revolution of the rotating mirror makes the pencil beam follow two conical traces symmetrical about the equatorial plane (see Figure 7). When the satellite is perfectly pointed, they cross the Earth horizon at 45° North an South latitudes respectively at a 1.25 Hz scanning rate.

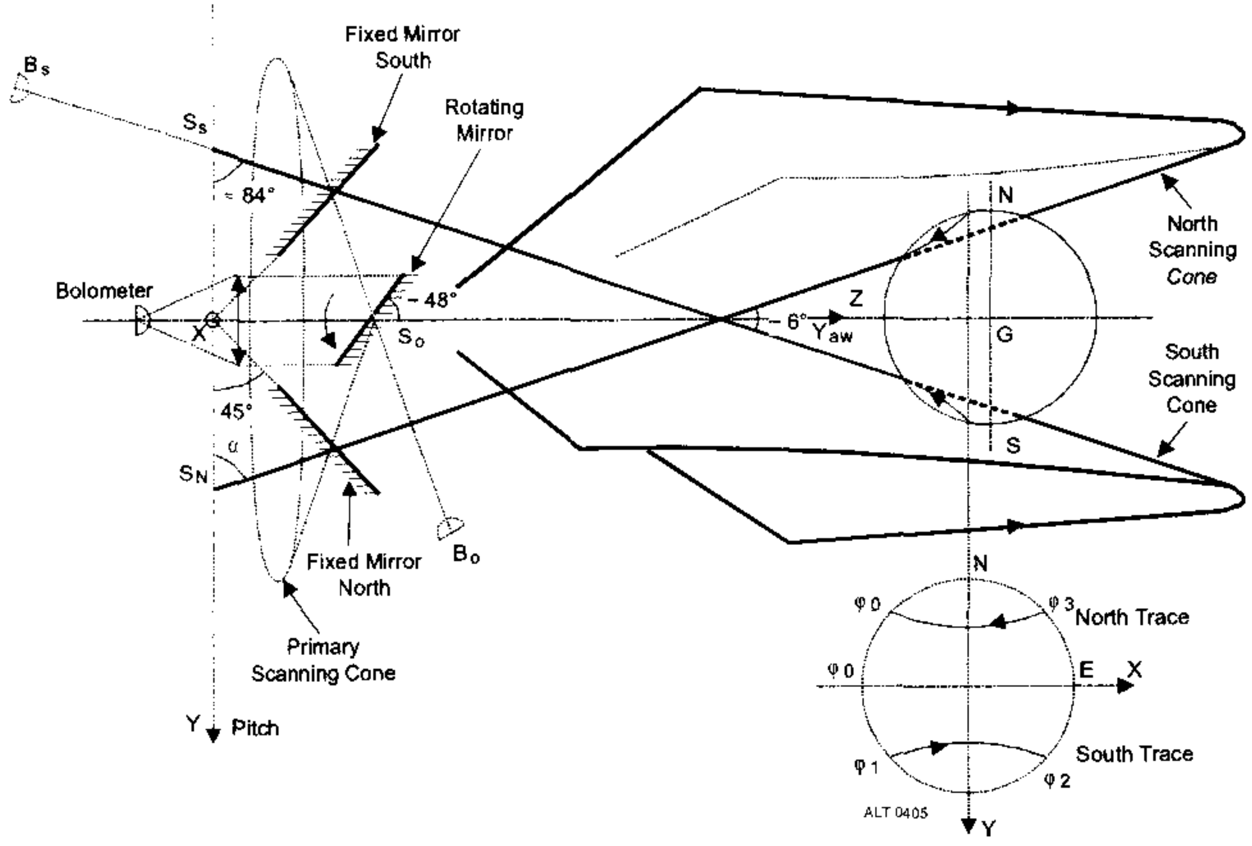

Figure 7. IRES scanning geometry

The IRES configuration has a zero tilt around pitch. IRES axis are aligned with satellite axis.

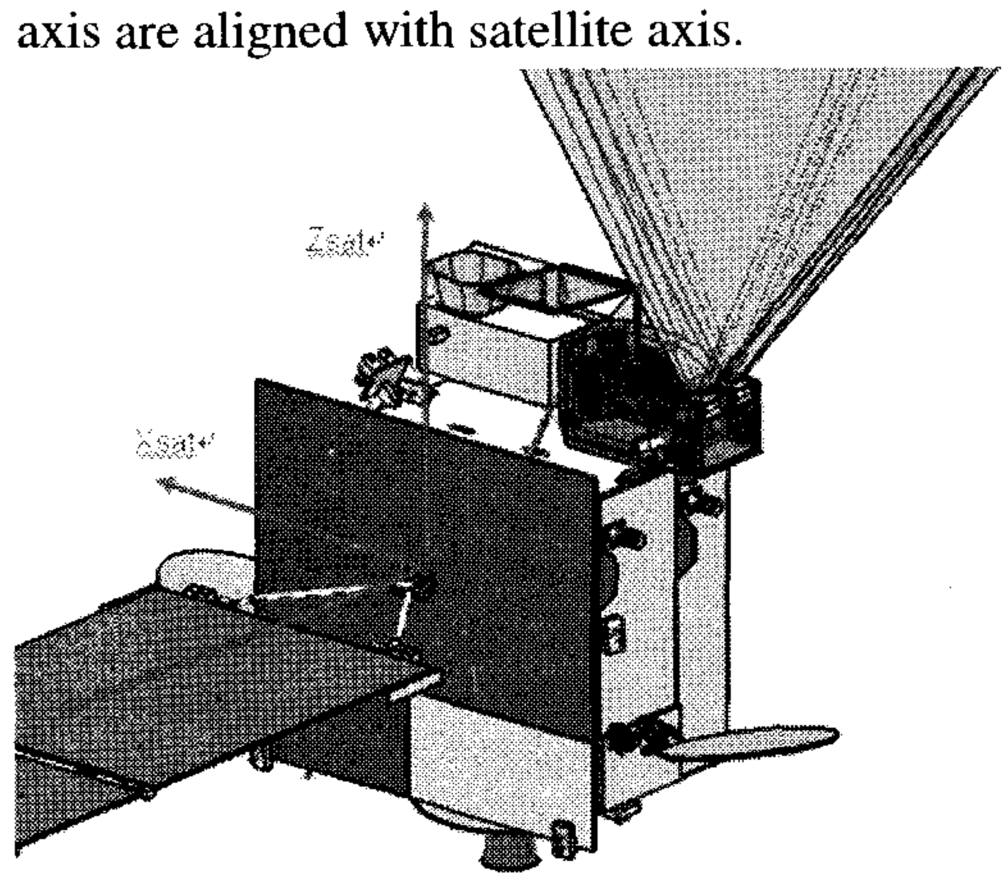

Figure 8. IRES configuration

2.4 FOG

Fiber Optic Gyroscopes (FOG) features two main components: A Sagnac interferometer assembly (SIA), mainly constituted by a fiber optic coil ended by an integrated optical circuit called IOC. SIA detects rotation rate around the fiber optic coil axis. An electronic module, (named FEM for FOG Electronic Module) featuring processing electronics to extract the inertial information from the optical signal coming out of the SIA interferometer, interface electronics to ensure dialog with satellite and ground tests systems and power distribution.

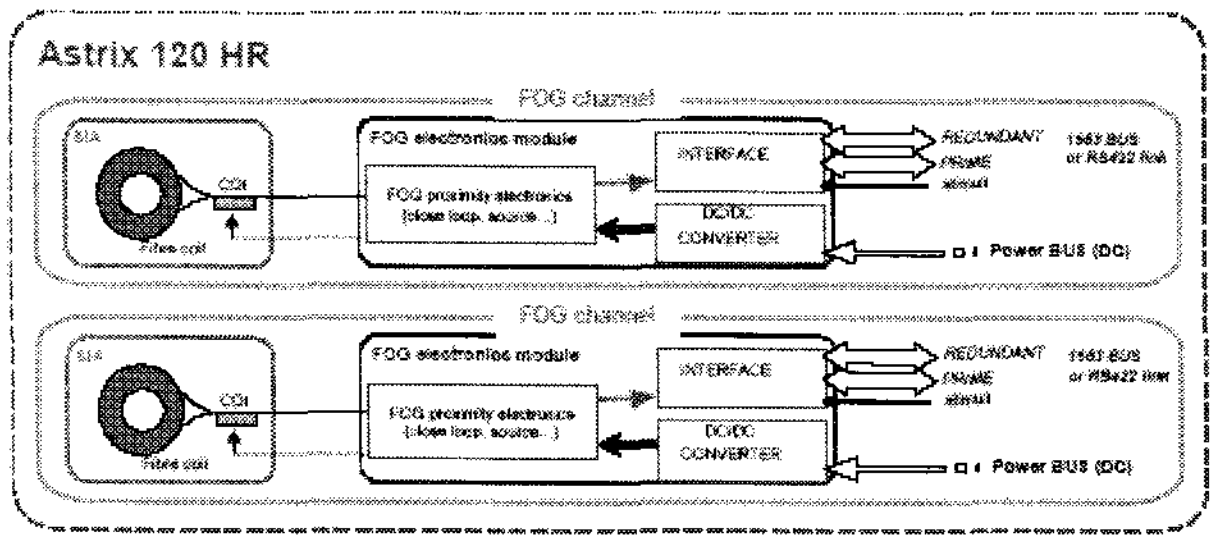

Figure 9. COMS FOG architecture synoptic

There are 3 FOG 120HR: One per satellite axis. Each FOG equipment has a cold redundant system. Each FOG axis is aligned with a satellite axis: +/-Xsat, +/-Ysat, +/-Zsat depending on nominal or redundant FOG axis.

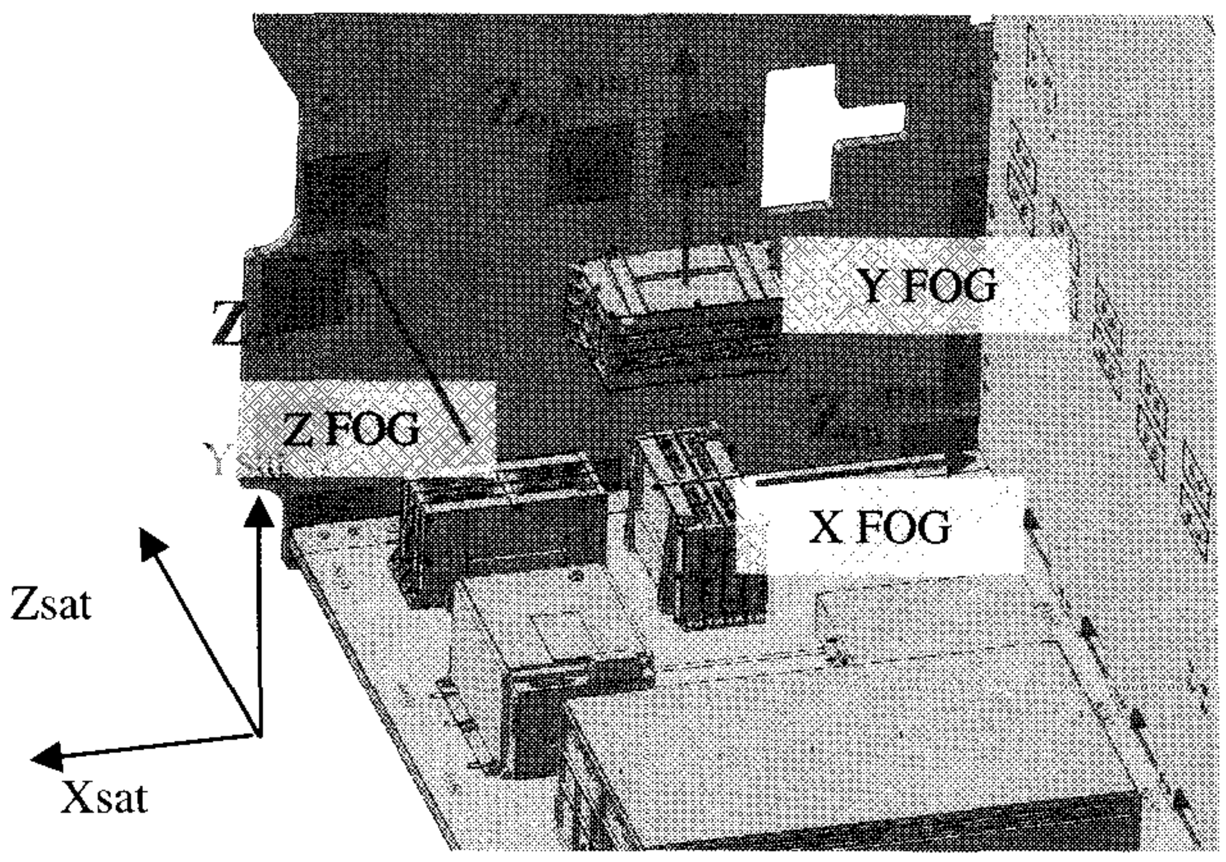

Figure 10. COMS FOG configuration

3. COMS AOCS ACTUATORS

3.1 Wheel

The configuration is composed 5 momentum wheels (RDR 68) with their dedicated electronics (WDE): 2 RDR along Ysat axis and 3 RDR in the XZ plane (with 120° angle in between). They are commanded by the ADE (Actuator Drive Electronics) with the power provided directly by the 50V primary bus to the wheels electronics. The redundancy scheme is that use of one among two RDR along Ysat and use of 2 among three RDR in XZ plane.

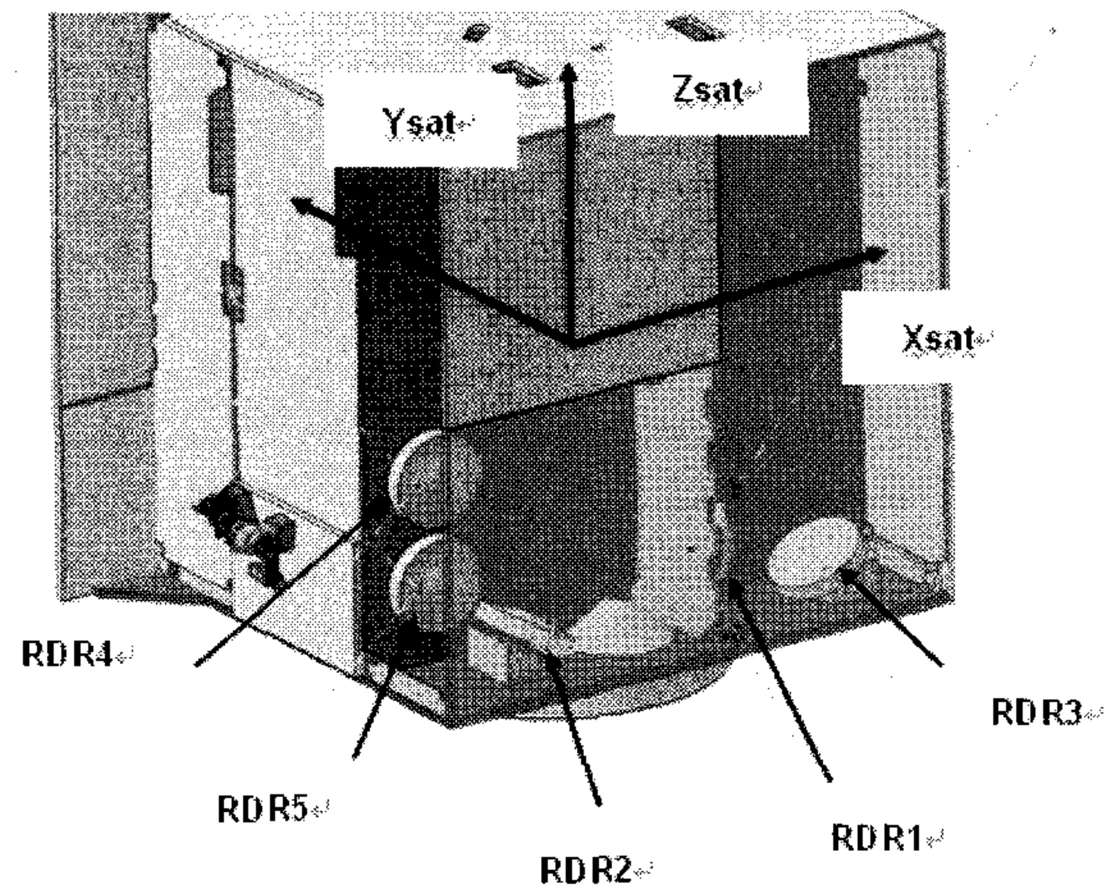

Figure 11. COMS wheel configuration

The wheel and the motor are mounted to the bearing unit and balanced as an assembly. Correction of static and dynamic unbalance is carried out by adding balance screws to the inner side of the rim in two separated planes. The flywheel mass is safe to at least 8000 rpm.

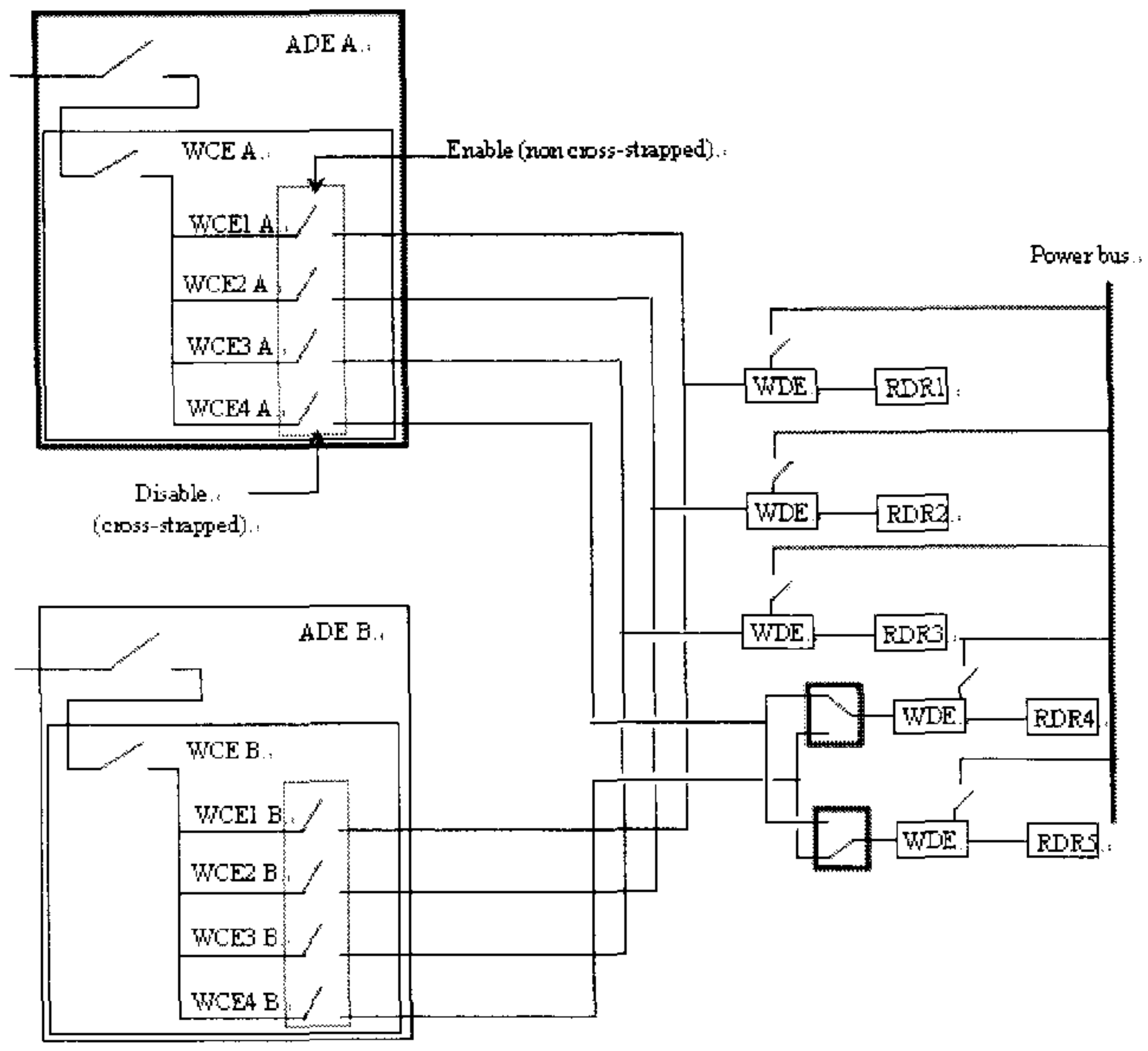

Figure 12. ADE/WCE connection

The connection between the ADE/WCE and the five wheels is depicted in Figure 12. RDR1, RDR2 and RDR3 (XZ plane RDR) are fully cross-strapped, they are connected to ADE/WCE prime (A) and redundant (B). These wheels can either be commanded by their corresponding command path A or B. RDR4 and RDR5 (Ysat RDR) are connected to the fourth nominal and redundant command path (WCE4-A and WCE4-B) through their cross-strapping relays.

3.2 Thrusters

Thrusters 6 & 7 are both mounted on the –Z panel and oriented toward +Z. They are used to create +Z thrust during LSP(Liquid Settling Phase) and pitch control torque during all thrusters controlled phases.

Thrusters 1, 2 and 3 are mounted on the +Y panel and are used for North/South station keeping manoeuvre (creating a force roughly in the -Y direction). The roll and yaw control torques are also generated with the thrusters 1, 2 and 3. Thus, during N/S CSK, control torques are obtained by modulating the "manoeuvre" thrusters (1, 2 and 3) and by actuating the others (6 and 7).

The manoeuvre efficiency depends on the plume force (opposite to the thrust) and the thrusters tilt angles chosen to reduce that plume effect. The thrusters configuration is optimized in terms of manoeuvre efficiency and transverse effects.

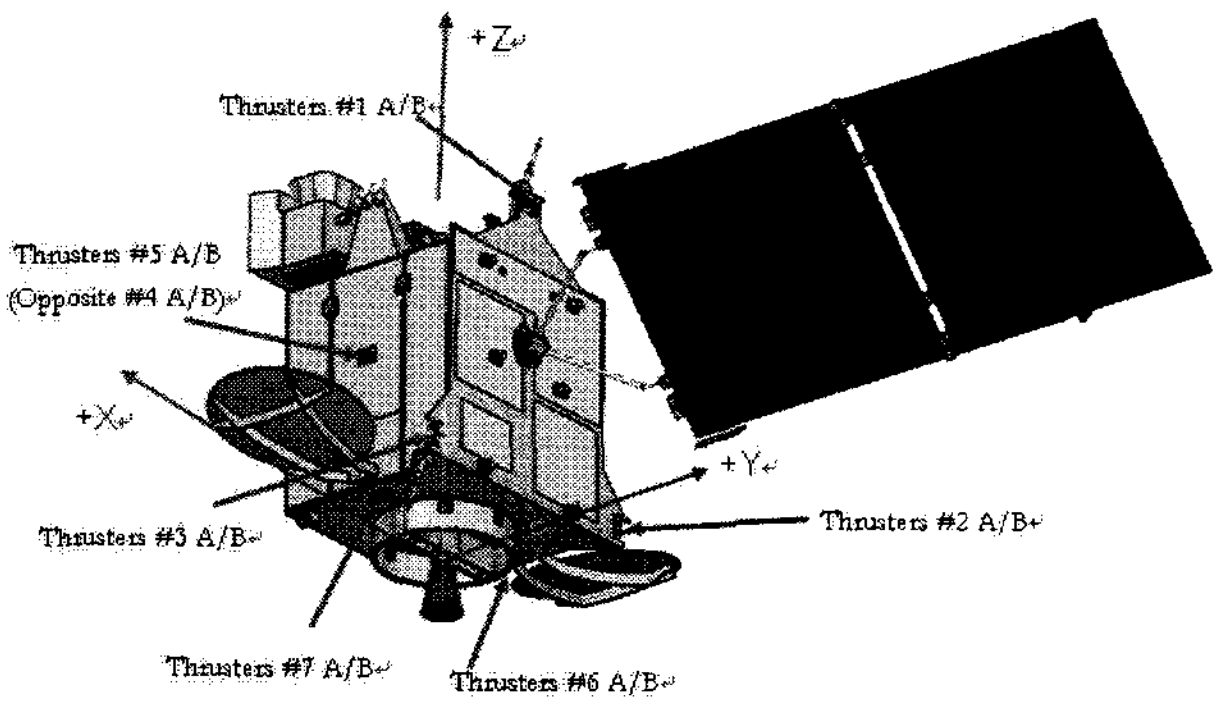

Figure 13. COMS AOCS thrusters layout configuration

Thrusters 4 and 5 are mounted on the –X/+X panel and are used for East/West station keeping manoeuvre. The tilt angle of thruster 4 and 5 is tuned to minimize the total torque: the torque due to the geometrical configuration compensates for the plume impingement torque (issued from the thrust flow on the reflector). Once the tilt angle is tuned, the thermal flux on the reflector and horn is computed in order to check that it is compatible with the maximum specified thermal flux.

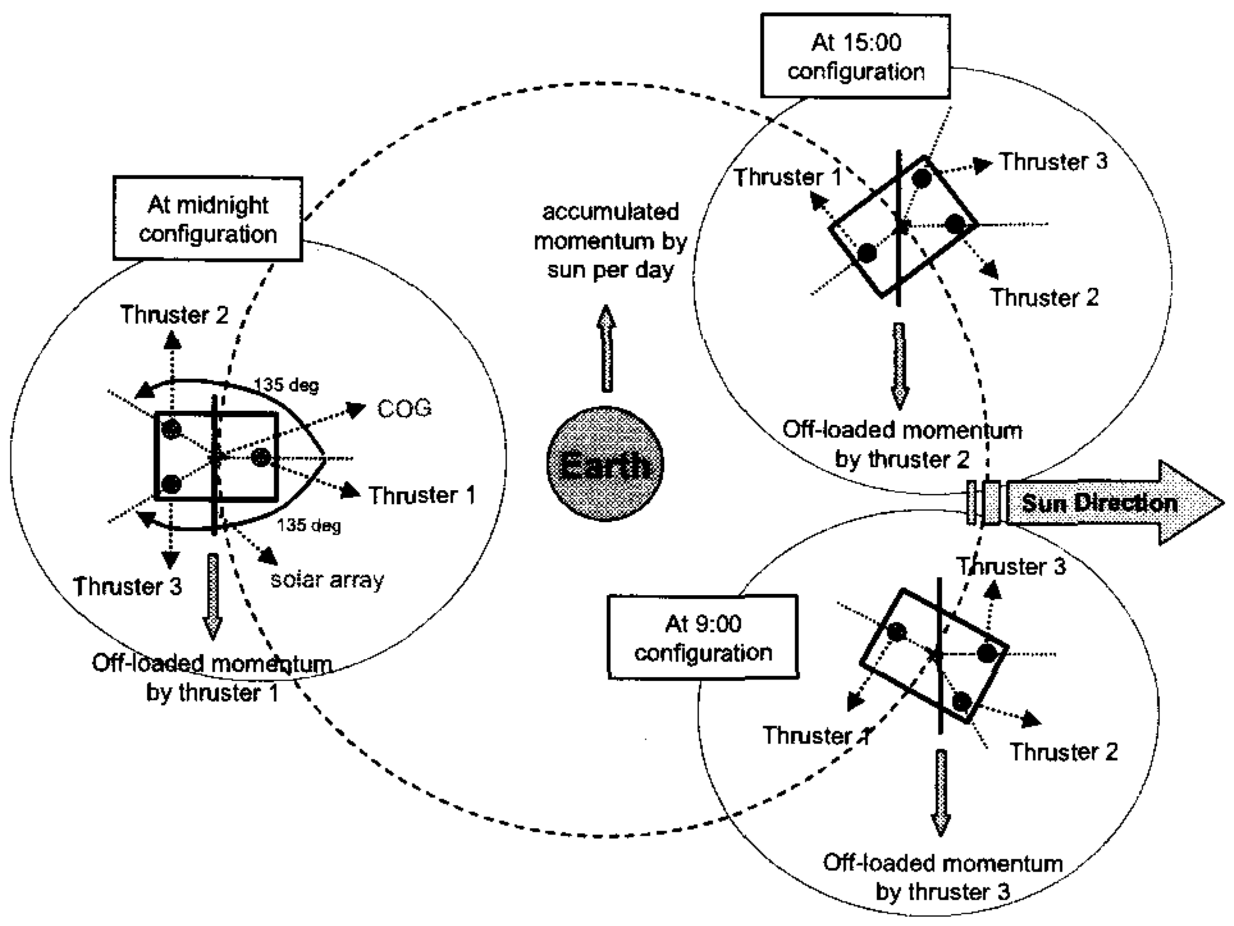

Figure 14. COMS AOCS off-loading strategy

These thrusters are used on wheel off-loading. The wheel off-loading for COMS shall be performed twice per day due to asymmetric solar array configuration.

The induced transverse angular momentum vector towards in the –Xsat axis at midnight, +Zsat axis at 6 hours, +Xsat axis at 12 hours, and –Zsat axis at 18 hours, respectively. As can be seen in Figure 14, thrusters 1, 2 or 3 on the south panel are used for the wheel off-loading depending on SLT(Satellite Local Time).[Park]

4. CONCLUSIONS

The hardware configurations of sensors and actuators for COMS AOCS are described in this paper. These configurations are optimized to perform the COMS bus mission on transfer orbit and geostationary mission orbit. There are several attitude changes in transfer orbit; Earth and Sun acquisition phases, LAE(Liquid Apogee Engine) burn phase, emergency phase, gyro calibration, etc. In mission orbit, wheel off-loading and station keeping phase are very important bus mission.

The changed hardware configurations from Eurostar 3000 bus heritage for COMS mission are FOG (new developed), wheel (capacity increased and 5 wheels).

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